Summertime nocturnal Low-Level Jet in Paris and its interactions with urban heat and topography

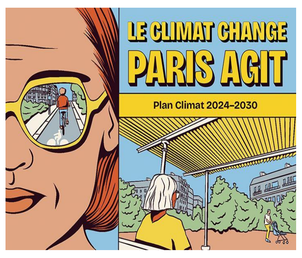
Jonnathan Céspedes[1] (j.cespedes@reading.ac.uk), Simone Kotthaus[1], Martial Haeffelin[2], Jean-Charles Dupont[4], Ludovic Thobois[5], Jana Preissler[5], Clément Toupoint[5] , Tim Nagel[6] , Aude Lemonsu[5] , Valery Masson[5]

[1]LMD-IPSL, Palaiseau Cedex, France, [2]Institut Pierre Simon Laplace (IPSL), CNRS, Palaiseau Cedex, France; IPSL, UVSQ, Palaiseau Cedex, France[4]; [5]Vaisala France; [6]Météo-France

1. Motivation, context and research questions

Cities are key in the exchange between humans and the atmosphere, they influence air quality and global climate change.

+



+

H2C HEAT & HEALTH IN CITIES

PANAME

Research questions:

1) How does the LLJ interact with the summertime Paris urban atmosphere?

i) What are the characteristics of the LLJ in the Paris region during summer?

ii) How do topography and urban atmosphere impact the LLJ?

Low-level jet (LLJ):
- strong wind at low altitudes
- surface drag on flow reduced by stable stratification

Characteristics of LLJ "core":
- altitude z_{LLJ}
- wind speed WS_{LLJ}
- wind direction WD_{LLJ}

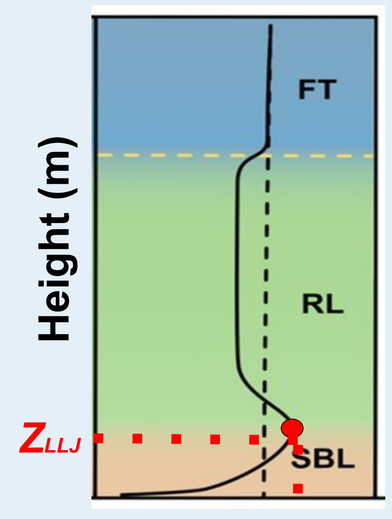
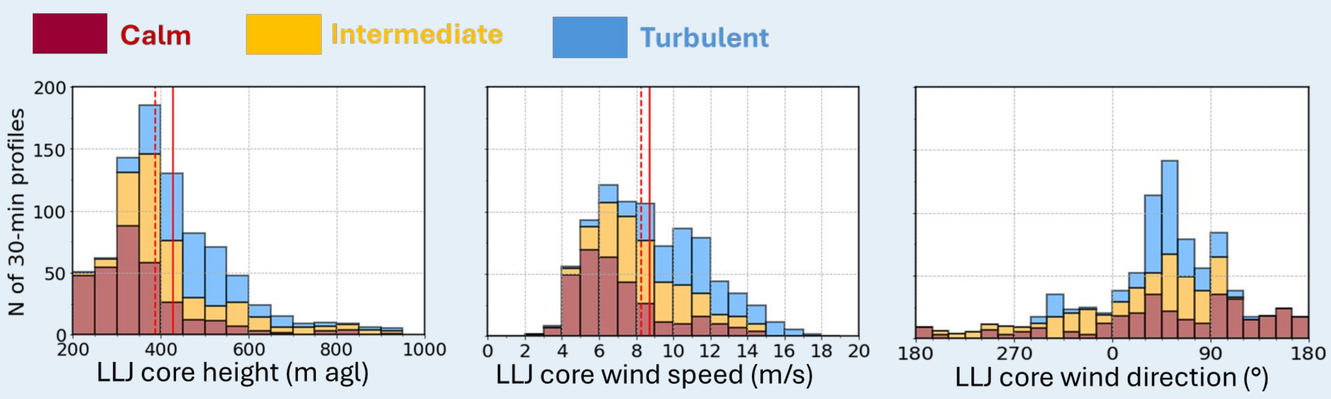


Figure 1: Wind profile with an example of LLJ (Kotthaus et al., 2022).

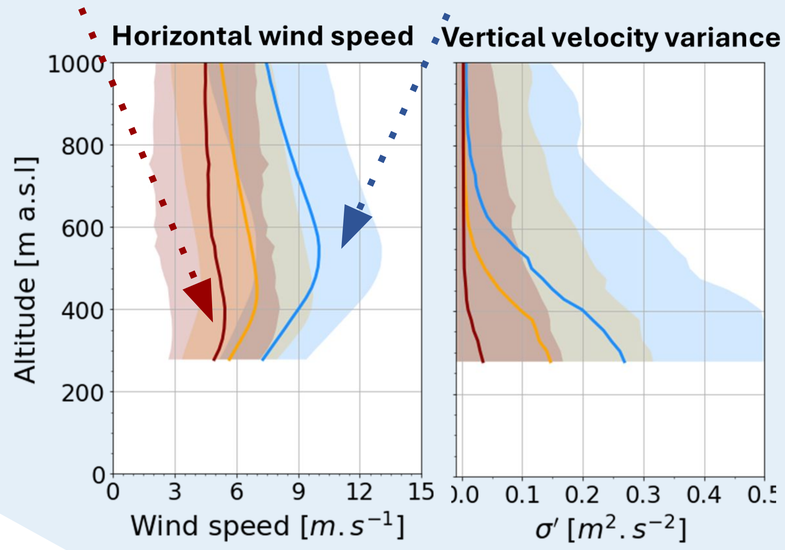
2. Methods and results

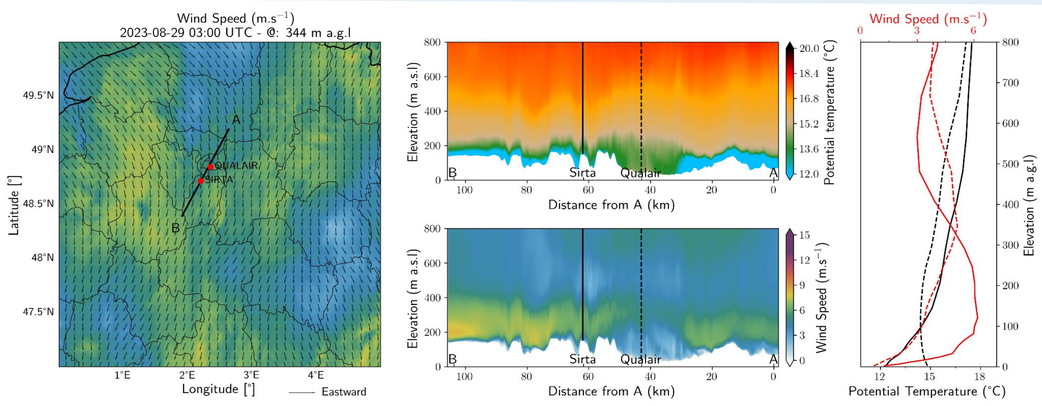
- LLJ core characteristics classified by vertical mixing (σ_w^2) @ first gate
- NE -> turbulent and SE -> stagnant (atmospheric stratification)



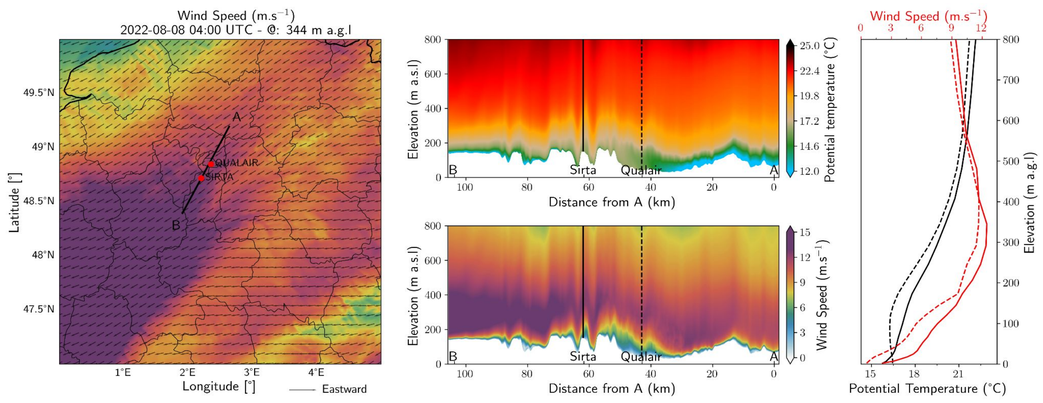
Low wind speed @ **low** altitude

High wind speed @ **high** altitude

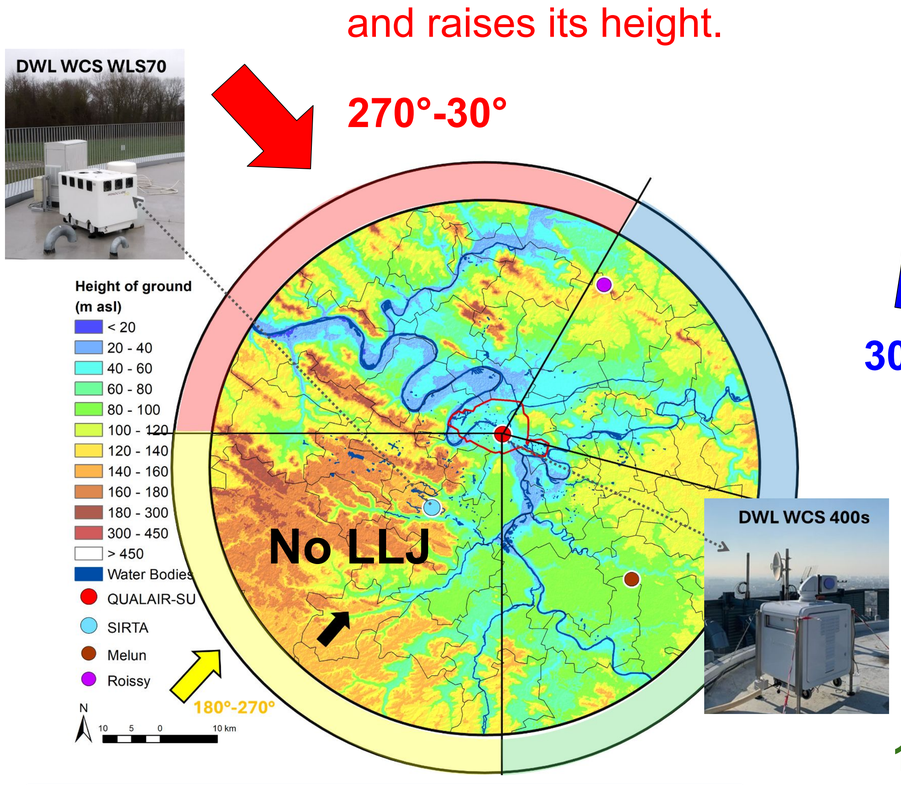




NE jets: fast and turbulent, they interact more with the terrain, pushing the flow upward at SIRTA.



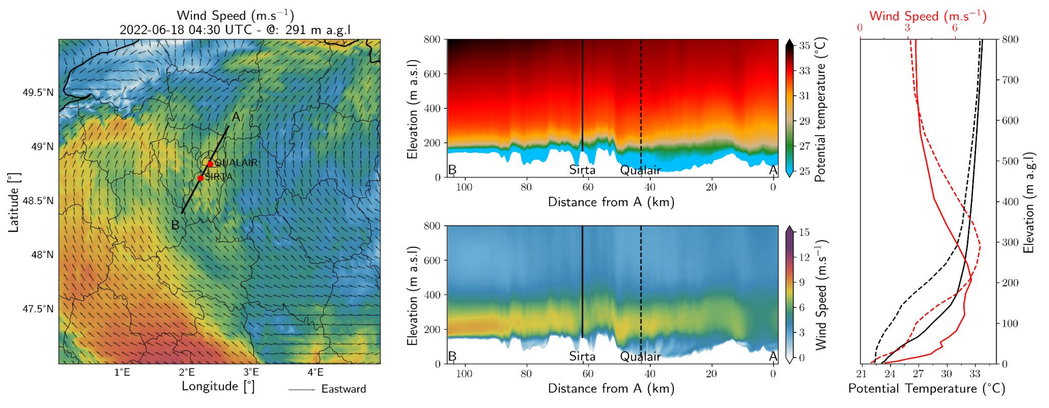
NW jets: urban buoyancy slows LLJ and raises its height.



30°-120°

120°-180°

SE jets: very stable atmosphere (low mixing), which limits interaction with terrain and urban buoyancy.



3. Conclusions

- The LLJ is observed in the Paris region during 60-80% the summer nights of 2022 and 2023 (Céspedes et al, 2024).
- Interactions of jet with topography and urban buoyancy depend on atmospheric stability and wind direction.
- Urban buoyancy elevates the LLJ core and weakens its velocity under moderate vertical mixing (Céspedes et al., 2025, in prep).

Acknowledgments

To SIRTA team, particularly to Marc-Antoine Drouin, Aurélien Faucheux, Christophe Boitel, and Jean-François Ribaud. QUALAIR-SU, particularly to Cristelle ailteau-Fischbach and Camille Viatte.